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time was 305 σ and the "motor" 188 σ . In all these results the attention was closely focused upon the reaction. If the attention were purposely diverted from the reactions and no signal preceded, the time was 353 σ . The chief result is thus a corroboration of the distinction between "motor" and "sensory" as well as of the effect of a preceding signal, with accurate determination of the effect of the interval between signal and stimulus upon the reaction-time; it is also shown that the advantage of the signal is greater with "sensory" than with "motor" reactions. The second portion of the research is devoted to the same problem with which Martius (see above) has occupied himself, *i. e.*, the correlation of the subject's own version of the value of his reaction and the state of his attention at the time of reaction. He finds that a complete attention takes place in 85 per cent. of all cases, and that total inattention is rare, and ventures the generalization that as the accuracy of the attention increases the time decreases. The subjective testimony would also indicate that the distinction between "sensory" and "motor" is only a relative one, transitional forms and times appearing everywhere. One's own opinion as to the quickness of the reaction, Dwelshauvers does not value as highly as Martius, but regards it as very liable to effects of contrast and other illusions of judgment. J. J.

Mental Tests and Measurements. J. MCK. CATTELL. *Mind*, XV, 373; July, 1890.

Prof. Cattell here presents in detail the plan for psychic tests mentioned in his note upon Psychology at the University of Pennsylvania in the last number of this JOURNAL. These are: 1, Dynamometer pressure; 2, Rate of movement; 3, Sensation-areas; 4, Pressure causing pain; 5, Least noticeable difference in weight; 6, Reaction-time for sound; 7, Time for naming colours; 8, Bi-section of a 50 cm. line; 9, Judgment of 10 seconds time; 10, Number of letters remembered on once hearing. Numbers 2 and 4 have not so far been much tried, but are promising; new instruments have been devised for making them. These ten tests are now taken at Prof. Cattell's laboratory upon all that are willing, and his students are submitted to a much longer series, a list of which is also here given. Discussion and co-operation is invited (and some notes by Galton are appended to this article) to the end of securing the best methods and uniformity in using them. This move is in the right direction; some standard series of mental measurements is a thing very much to be desired, and uniformity is no less important. Prof. Cattell has upon the stocks a laboratory manual of psychology, a book much needed at this stage of the teaching of experimental psychology.

Ueber die Wahrnehmung und Lokalisation von Schwebungen und Differenz-tönen. KARL L. SCHAEFER. *Zeitschrift für Psychologie und Physiologie der Sinnesorgane.* Bd. I, H. 2. 1890.

That the ear has a certain power of judging the direction and distance of sounds, no one will deny, but how will it locate those that actually have not a single source, that arise from the combination of two other sounds? The most readily audible of such sounds, "beats" (due to interference) and difference-tones, (due to the mechanism of the ear) have been examined in this particular by Schaefer. His experiments were made with tuning forks and lead to the following results. Beats: When the beating tones are of unequal intensity the stronger of the two fixes the apparent place of the beats; when they are of equal intensity the beats are referred to the intermediate space—thus, as a special case, when one tone reaches one ear only and the other tone the other ear only, the location of the beats is in the median plane or even in the middle of the head. Difference-tones: When the generating tones are

produced in the median plane of the body or symmetrically on either side of it (and at the same time are equally intense) the difference-tone seems to be in the median plane within the head, sometimes mid-way between the ears. When both generating tones are on one side of the head the difference-tone is heard in or near the ear on that side and is not referred to the generating tones. When the generating tones are not equally intense, one being produced before one ear the other before the other, the difference-tone is heard on the side of the fainter generating tone—a result due apparently to the more favorable relation of intensities existing on that side. Dove, Stumpf and Thompson failed to hear the difference-tone with the generating tones in this position, but probably because of imperfect conditions. The 32 forms of experiment contributing these results, as well as notice of the effect of different positions of the generating tones upon the intensity of the “beats” and difference-tones, are set forth in the original. [These results are in harmony with the general principle that a sound is located upon the side on which it is most intensely heard; or if equally intense on both sides, in the median plane. REV.]

Die Association successiver Vorstellungen. H. MÜNSTERBERG. Zeitsch. f. Psychol. Bd. I, H. 2. 1890.

The theory of association here advocated by Münsterberg is that the connection of any two members of a memory series depends either on their more or less complete simultaneousness in consciousness (or the simultaneousness of their nervous correlates), or, if successive, on their connection with the members of a parallel motor series (made up of the reflex movements or tendencies to movement which attend sensory processes). Thus sensory image *a* is connected, because simultaneous, with motor impulse *A*, the latter with motor impulse *B*, and that in turn with sensory image *b*. Image *a* can thus call up image *b* indirectly though wholly lacking direct connection. In addition to a statement of the difficulty of conceiving the connection of neurological processes wholly successive, the author presents experiments going to show a connection by way of these motor accompaniments. The experiments fall into two groups. In the first written letters are exhibited in such a way that each letter was seen by itself for one second till from four to ten had been shown. The subject, Münsterberg himself, was required to fix the series in mind and at the end repeat the letters in order. He found that he was able to repeat seven letters without error, but reached the limit of his ability with a series of 10. The errors which he made, and this is the important point, were mostly the substitution of wrong letters, *almost never errors in order*; taking reproductions of series of all lengths only about 1 per cent. were affected by errors of this kind. In the second group the setting of the experiment was the same as in the first; but the subject, instead of being able to concentrate his mind on holding one letter till the next came or even to say them in his head, was deprived of such aids by being required to work problems in mental arithmetic aloud (such as adding continuously), while the letters were shown. The result was a fall of the limit of possibility from 10 to 7-letter series, and of that of perfect reproduction from 7 to 4 or 5. More important, however, is the fact that *the order of letters, even when the right ones were given, was very frequently wrong*. Of 100 4-letter series only 6 contained wrong letters, but 52 were wrong in order; of 100 5-letter series, 10 contained wrong letters and 64 a wrong order; and the 6-letter series were very much worse. The effect of simple distraction of attention shows itself in the fall of the limits of possible and perfect reproduction, but the errors in order must have another explanation. This is to be found in the fact that the mind was not at liberty to hold one letter till the next came (hence association by simultaneousness was